"I am painfully conscious how little I deserve this recognition of the little I have done.

"It is a matter of great commercial importance to this settlement to have the road open to the Niger, in the Sangara country, and Mr. Reade has nearly accomplished this, having reached as far as Falaba, capital of the Soolima country; and if he gets no further, I have made arrangement this very day with the son of a chief who will guarantee the safety of any one I may send next dry season. This young man describes the whole route as easy, about a month's journey, plenty of horses, country fine and salubrious, and people industrious and most anxious to be visited by white men.

"In enclose copy of Mr. Reade's last note, in case you are without information.

"I am doing very little towards letting in daylight upon West Africa, where our trade is becoming more extensive and valuable daily. I myself came to this coast in the first mail or commercial steamer (the *Forerunner*) which ever came to West Africa, and there are now four first-class steamers per month running out and home full of cargo. I see no limit to the development of trade on this coast, if we can extend our influence and maintain peace in the interior. You are probably aware that, having crossed the bar and ascended the hitherto inaccessible river Volta this year, with the very valuable aid of Captain Glover, R.N., and a little colonial steamer, we remained in the river for 14 days, and made a survey of the bar and entrance. It is a grand stream, free from mud and swamp, and opening a rich and valuable country.

"I shall always be glad to receive any suggestion you will be kind enough to offer me in forwarding the view of your Society.

"I am, my dear Sir, your very faithful servant,

"A. E. KENNEDY.

"Sir Roderick Murchison, Bart."

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5. *Note on the Determination of Heights, chiefly in the Interior of Continents, from Observations of Atmospheric Pressure.* By ALEXANDER BUCHAN, M.A.

(Extracted from the Proceedings of the Royal Society of Edinburgh, 1868-9).

THE weight or pressure of the atmosphere is ascertained by the mercurial barometer, the aneroid, or from the temperature of the boiling-point of water. The height of a hill is measured barometrically, from observations made simultaneously at its base and top, and the application of certain well-known formulæ. The height of a place at no great distance from another place whose height is known, and at which observations are made about the same time, may similarly be ascertained with a close approximation to the truth.

But with regard to places far from any place of known elevation, or from any place at which meteorological observations are made, it is plain that the height can only be computed by assuming a certain pressure as the sea-level pressure at that place.

In the Table giving the reductions of heights from Captain Speke's observations, it is stated ('Journal of the Royal Geographical Society,' vol. xxxiii.), that a mean pressure of 29·92 inches was assumed as the mean sea-level pressure,—that is, if those parts of Africa visited by Speke had been on the same level with the sea, it is assumed that the mean pressure of the atmosphere would have been 29·92 inches.

In the last revised 'Hints to Travellers,' prepared by the Royal Geographical Society, and published in the 'Journal,' vol. xxxiv., it is stated at page

286, "When the boiling-point at the upper station alone is observed, we may assume 30·0 inches, or a little less, as the average height of the barometer at the level of the sea. The altitude of the upper station is then at once approximately obtained from the tables." So far as I have been able to ascertain, this mean height of the barometer has been generally accepted by travellers as applicable to all seasons, and to all parts of the globe at great distances from Meteorological Observatories. Unfortunately, it has hitherto been generally the practice for travellers, or those who have been intrusted with reducing their observations, to give only the heights deduced from the observations, with a curious minuteness of accuracy, and not the observations themselves. Since the tables which have been prepared for travellers are calculated on the assumption that 29·92 inches, or 30·0 inches, is the zero point for heights, there can be little doubt that, by this method, the heights of many plateaux and mountains of the globe have thus been determined.

From my paper, read before this Society in March, 1868, on the "Mean Pressure of the Atmosphere over the Globe," illustrated with three charts, showing the *Mean Isobaric Curves* for July, January, and the year, it may be seen that a pressure of from 29·9 to 30·0 inches is very near the mean annual pressure over the greater part of the globe, particularly over those portions of it explored by travellers. But when we examine the months, it is at once apparent that 29·9 inches is very far from the mean pressure in many regions. This point will be illustrated by the pressures at Barnaul, Siberia, which on average of 19 years are reduced to 32° and sea-level, as follows:—

	Inches.
Mean atmospheric pressure at Barnaul in July	29·536
,, ,, ,, January	30·293
,, ,, ,, Year	29·954

Suppose, now, it be proposed to ascertain the height of Lake Balkash on some day in July, the pressure at the time being the average of the month. Let the observed pressure be 28·8 inches reduced to 32° Fahr., and the temperature of the air be 70°·0, then if the sea-level pressure be assumed to be 29·9 inches, it is plain that the difference due to height is 1·10 inch; in other words, the height of the lake would be, in round numbers, 1080 feet. But since the sea-level pressure of this locality, which is nearly that of Barnaul, is 29·536 inches, the difference of pressure due to height is only 0·736 inch; the height, therefore, is only about 730 feet. Again, if in January, when the barometer is the mean of the month, the pressure at Lake Balkash was observed to be 29·42 inches, and the temperature of the air 1·0°, assuming that 29·9 inches is the mean sea-level pressure of January, 0·48 inch is the difference of pressure due to height—that is, the lake is about 400 feet above the sea. But since the mean pressure is nearly 30·3 inches, 0·88 inch is the pressure due to height; the lake is therefore nearly 730 feet above the sea. Thus in July the lake would be made 350 feet too high, and in January 330 feet too low—the difference of the two observations, each being here supposed to be taken under the most favourable circumstances, and with the greatest accuracy, being 680 feet.* Observations made in the first half of April, or in the latter half of October, when the pressure is the mean of the year, supply the best data for the calculation of heights.

If the best physical atlases be examined, and the heights, given by different authorities, of table-lands and mountains, of Central Asia, Central Africa, and

* The height of Lake Balkash, according to the Russian explorers Semenoff and Golubeff, may be anywhere between 530 feet as given by the former, and 1200 feet as given by the latter. For a large number of heights made use of in writing this note, the author is indebted to Mr. Keith Johnston, jun.

the highlands of the United States and British America be compared, considerable confusion will be found to prevail.

One or two examples may be given to show the application of all this. From barometric observations made on the 28th November, 1838, the level of the Dead Sea below that of the Mediterranean was calculated to be 1429 feet. The real depth of this sea below the level of the Mediterranean, as determined by the English engineers by levelling, is 1296 feet. Now, since the mean pressure of the atmosphere over the region of the Dead Sea in the end of November is about 30·035 inches, it is seen, if the sea-level pressure was assumed to be 29·9 inches, how the lake came to be lowered 133 feet.

Much interest is at present attached to the heights of Central Africa. The following mean pressures at 32°, and sea-level, bear on this interesting question:—

	January. Inches.	July. Inches.		January. Inches.	July. Inches.
Malta	30·07	30·01	Cape Town	29·97	30·20
Algiers	30·15	30·06	Graff Reinet ..	29·91	30·22
Laghouat (Algeria)	30·07	29·86	Maritzburg	29·89	30·19
Gibraltar	30·18	30·06	Mauritius	29·95	30·19
Christiansborg ..	29·92	30·04	Aden	30·03	29·69
St. Helena	30·05	30·18	Alexandria	30·06	29·80
Grahamstown ..	29·91	30·15			

Thus the difference at Graff Reinet and Maritzburg between the January and July pressures amounts to about 0·30 inch. From this it may be inferred that, in calculating heights along the Zambesi, from observations made at different seasons, if no allowance be made for the monthly variation, but if 29·92 inches be assumed as the height for all seasons, the results from observations made in January will differ from 250 to 300 feet from those obtained from observations made in July at the same place. If no account be taken of the daily variation of the pressure, the observations made in July at 9 A.M. will give a difference of from 350 to 400 feet in height, as compared with results from observations made in July at 4 P.M. All this large error is avoided when the monthly and the daily variations are allowed for.

It has been seen that the summer pressure in Central Asia falls in July to about 29·50 inches. It might be inferred by analogy that the pressure in Central Africa also falls considerably below 29·92 inches over those regions where the sun is nearly vertical; and, as a consequence, that this space of low pressure moves north and south with the sun, attaining its northern limit in July, and its southern in January. The figures in the Table given above fully bear out this supposition. Thus, in July at Algiers, the mean pressure is 30·06; but at Laghouat, between 280 and 300 miles inland, the pressure is only about 29·86 inches; at Alexandria it is 29·80; and at Aden, only 29·69; and since, in the same month, according to Speke, the wind in Central Africa near the equator and long. 32° 20′ E. is almost constantly south-east, it is probable that the pressure there is lower than at Aden. Taking the whole facts into consideration, it can scarcely be less than 29·70 inches, though probably it is lower. Again, in January the pressure at Cape Town being 29·97 inches, at Graff Reinet 29·91 inches, and at Maritzburg 29·89 inches, points still further to a diminution of pressure in the centre of Southern Africa at this season, increasing from the coast—falling, probably to between 29·70 and 29·80 inches. Hence, if we assume 29·70 inches as the low pressure which accompanies the sun over those parts of Africa where he is nearly vertical, we shall not be far from the truth.

Let us apply this reasoning to the determination of the height of Albert Nyanza from Sir Samuel W. Baker's observation of the boiling-point of water. The observation was made in lat. 1° 14′ N., long. 30° 50′ E., on 14th March,

1864, between 8 and 10 A.M., probably at 9 A.M. The boiling-point of the thermometer was 207·8°, but as it changed while in Sir Samuel Baker's possession, it is supposed that the true reading was about 207·3°, which corresponds to a pressure of 27·231 inches.* But since the observation was made about 9 A.M., when the pressure is about the maximum of the day, subtracting ·043 inch as the correction for daily range in July, we obtain as the mean pressure of the day 27·188 inches. If we assume the sea-level pressure to be 29·70 inches, the difference due to difference of height will be 2·512 inches, and the temperature of the air being at the time 84·0, the height of Albert Nyanza will be in round numbers about 2550 feet, or considerably under the height usually given.

Similarly, by the same reasoning, Gondokoro, calculated from Sir Samuel W. Baker's observations to be 1999 feet in height, will be only about 1800 feet above the level of the sea.

Considering the small difference within the tropics in the mean pressure of any month, say July, from year to year, it follows that if recent African travellers had been provided with good thermometers for determining the boiling-point of water, and had made carefully conducted observations with them, noting the precise hour and month of the observations, one of the great problems of African travel would have been already solved, viz., whether Lake Tanganyika does or does not flow into Albert Nyanza, unless the difference of level between these two lakes is comparatively small. But since travellers have been given to understand that the heights deduced from their observations may be in error to the extent of from 300 to 500 feet, less care has been bestowed in making such observations than would otherwise have been the case.

In extra-tropical regions the height of the barometer is much more fluctuating, and the pressure during any month from year to year varies more than within the tropics. But even in these regions the limits of error are much less than are usually supposed, if care be taken to make the observations full and precise, so that when they come to be reduced it may be in the power of the meteorologist to value them at their proper worth. This remark may require a little explanation.

In temperate regions barometric fluctuations are more frequent and of greater amplitude in such countries as Great Britain, which are situated between a continent on the one hand and an ocean on the other, than in the interior of continents in the same latitudes. Now, since it is to the interior of continents, viz., Asia, Africa, North and South America, and Australia, that these remarks on the discussing of heights are intended to apply, the limits of error of single observations, or groups of observations, of the pressure of the atmosphere, are much less than one accustomed to observe barometric fluctuations in Great Britain might be led to suppose. Hence, if the mean monthly sea-level pressure of the part of the earth's surface where the observation is made be kept in mind, the difference between this pressure and the observed pressure will be a tolerable approximation to the true difference of pressure due to the elevation of the place.

But a still closer approximation may be reached. All examination of weather on a large scale shows, in the most conclusive manner, that barometric fluctuations are always attended with changes of weather of a well-marked and determinate character. Hence, conversely, if travellers kept a careful record of the weather some time before and some time after they made their observations of the pressure of the atmosphere, some idea could be formed as to whether the observed pressure was above or below the mean pressure of the season at the place.

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* Regnault's Tables, revised by Moritz.

Thus, suppose that for some time before and after the observation the weather was fine and of a steady character throughout, the nights not much colder and the days not much hotter than usual, the winds light, or if moderate, continuing in one direction, and the state of the sky with respect to cloud much the same from day to day, it might be assumed that the pressure was the average of the season. Observations carefully made under these conditions are entitled to be ranked in the first class, as being the most trustworthy that can be obtained.

But if the nights have been for a day or two colder, the days hotter (in the sun), the air drier, and the winds lighter, and calm weather more prevalent than usual, then it is probable that the pressure at the time of observation was above the average of the season.

Again, suppose, in the north temperate zone, the air to have become warmer and moister, the sky clouded, rain to have fallen, and the wind veered from E. or S.E., by S. and S.W. to N.W., or suddenly shifted to W. or N.W., and the weather then to have become colder and clearer and the air drier, it is certain that a storm of greater or less magnitude has passed over the region, and since such storms are attended with great fluctuations of the barometer, it is plain that if the observation of pressure was made during these changes, it is worse than useless as a datum for the determination of the height of the place. It should, therefore, be altogether rejected.

These cases are given as examples of the method by which observations, as made by travellers, should be critically examined before they are made use of in calculating heights. It is probably from inattention to these simple directions—travellers not recording the required data, which can all be recorded without instruments, and computers not giving weight to such observations when recorded—that a large number of the grosser discrepancies, given in works of Physical Geography, have arisen. Many of the larger errors are, of course, due to the use of imperfect instruments and a want of practice in the observer.

An illustration of errors in the statement of heights may be given. The following places are situated in the neighbourhood of the Ural Mountains; the heights are those given by the most recent authorities, and a column is given showing the number of years for which the averages of mean annual pressure have been calculated:—

Place.	Lat. N.	Long. E.	Height in Feet.	Years of Average.	Mean Pressure at 32° and Sea-level.
	° ′	° ′			Inches.
Bogoslovsk	59 45	60 2	600	26	29·862
Nijni-Tagilsk	57 57	59 53	730	21	30·088
Catherinenburg	56 49	60 35	800	18	29·835
Zlatoust	55 10	59 40	1200	28	29·835

From the above annual mean pressures it is evident that the height of Nijni-Tagilsk is over-stated, the true height being probably about 250 feet less than what has hitherto been assigned to it.

Since it has, unfortunately, been the general practice not to publish the original observations, but only the heights deduced from them, it will be impossible, except in a comparatively small number of instances, to apply the principle brought forward in this paper to past observations.

Observations for the ascertaining of heights must, to be satisfactory, include the following particulars:—

1. Latitude and longitude of the place.
2. The date of the observation, giving exactly the year, the month, the day of the month, and the hour of the day.
3. The observation itself exactly as made; if with a barometer or aneroid, the pressure to be given; if with a thermometer, the boiling-point to be given, and not merely its equivalent in pressure.
4. The temperature of the air in shade.
5. The weather for two days before and after the observation, showing the temperature of the air, its probable humidity as made known by the feelings or by its effects on surrounding objects, the amount of cloud, the rainfall, the direction, veerings, shifts, and force of the wind, together with any striking phenomena that may occur.

To these might be added, if possible, observations of the wet-bulb thermometer.

It will be evident from these remarks that the physical geographer will require the practised meteorologist to aid him in settling the important physical problem of heights for large portions of the earth's surface.

6.—*Eastern Siberia and the Amoor.* By Ronald Bridgett, Esq.

The following pages are written from personal observation and information derived on the spot during the autumn of last year.

Commencing with the most eastern portion of the vast Empire of Russia, we find the Pacific seaboard organised in 1858 as a separate Provincial Government, under the style of the Maritime Province of Eastern Siberia, and extending from the Corea in the south to Behring's Straits in the north, while inland it reaches Khabarofka on the Amoor in long. 155° E. The existing settlements in the south are at Possiet Harbour and Vladiovostock (Port May), both forming capital anchorages, and the latter destined, ere long, to become the chief naval depôt of Russia in the Pacific, as the navigation is closed by ice for only two months in the year, while Nicolaievsk, the present rendezvous of the fleet, is difficult of approach, and frozen up for more than six months. The coast line of Manchuria is very mountainous, but inland towards the Lake Kinka and River Ussouri exist tracts of land capable of producing rich crops of grain. From Vladiovostock a telegraph line exists by way of the Rivers Ussouri and Amour to the head-quarters at Nicolaievsk. Large game exists in numbers, and it is not uncommon to see three or four tigers at one time. A small station likewise exists at Port Imperial or Barracouta Bay in lat. 49° N. On the opposite side of the Gulf of Tartary, on the Island of Saghalién, Russia maintains one or two military posts, the one to the south was situated at Kussonei in lat. 48½° N., and regarded as the Japanese frontier, but by a mutual understanding with the Japanese for the interchange of colonists, the Russians last summer made a commencement by sending down to Amioa Bay on La Perouse Strait a battery of artillery and a company of soldiers! A Russian post formerly existed at this place, but was withdrawn. The other station on Saghalién is at Doui, in lat. 50¾° N., three miles south of Jonquière Bay, nestling in a gap in the mountains, and not distinguishable from the sea, except by the lighthouse built on the hill above. It consists only of a few log huts and barracks for the soldiers employed to guard about 70 convicts of the worst class, murderers and others who are looked upon as beyond the pale of the law, and not subject to the same restrictions as regards personal chastisement as other criminals, four to five hundred lashes being the punishment awarded for a trivial offence. Here, as in other parts of Saghalién, coal is found on the surface, and the seams may readily be traced on the